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Glaser et al.

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(54) **WHIPSTOCK ASSEMBLY HAVING ANCHOR AND ECCENTRIC PACKER**

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E21B 33/128	(2006.01)
E21B 29/06	(2006.01)
E21B 33/129	(2006.01)
E21B 23/01	(2006.01)

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CPC ***E21B 23/002*** (2013.01); ***E21B 23/01*** (2013.01); ***E21B 29/06*** (2013.01); ***E21B 33/128*** (2013.01); ***E21B 33/1293*** (2013.01)

(58) **Field of Classification Search**

CPC E21B 23/002

USPC 166/117.6

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,153,109	A	5/1979	Szescila
4,285,399	A	8/1981	Holland et al.
4,304,299	A	12/1981	Holland et al.
4,307,780	A	12/1981	Curington
4,397,355	A	8/1983	McLamore
4,765,404	A	8/1988	Bailey et al.
4,807,704	A	2/1989	Hsu et al.

(Continued)

FOREIGN PATENT DOCUMENTS

WO	01/77480	A1	4/2002

OTHER PUBLICATIONS

First Office Action in counterpart Canadian Appl. 2,892,567, dated Jul. 11, 2016, 4-pgs.

(Continued)

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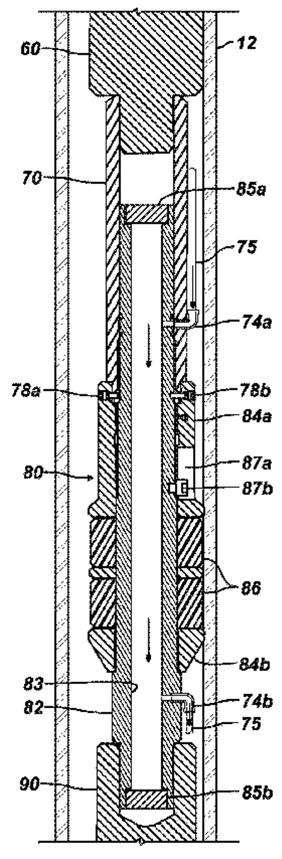
(57) **ABSTRACT**

A whipstock assembly has a whip, a packer, and an anchor. The packer connects between the whip and the anchor and sets after the anchor is set. The anchor can be set mechanically or hydraulically. To communicate hydraulic pressure to the hydraulically-set anchor, the packer can have an internal bypass for communicating fluid or for passing a hydraulic line from the whip to the anchor. The packer is set mechanically with set down weight applied from the whip via a setting tool or the like. The packer sets eccentrically in the casing and acts as a fulcrum to push the tip of the whip against the inside of the casing.

29 Claims, 13 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,154,231	A	10/1992	Bailey et al.	
5,163,522	A	11/1992	Eaton et al.	
5,318,132	A	6/1994	Odorisio	
5,335,737	A	8/1994	Baugh	
5,341,873	A	8/1994	Carter et al.	
5,379,845	A	1/1995	Blount et al.	
5,425,417	A	6/1995	Carter	
5,425,419	A	6/1995	Sieber	
5,427,179	A	6/1995	Bailey et al.	
5,429,187	A	7/1995	Beagrie et al.	
5,452,759	A	9/1995	Carter et al.	
5,467,820	A	11/1995	Sieber	
5,467,821	A	11/1995	Sieber	
5,474,125	A	12/1995	Sieber	
5,474,131	A	12/1995	Jordan, Jr. et al.	
5,474,133	A	12/1995	Sieber	
5,499,682	A	3/1996	Sieber	
5,531,271	A	7/1996	Carter	
5,533,573	A	7/1996	Jordan, Jr. et al.	
5,584,350	A	12/1996	Schnitker et al.	
5,592,991	A	1/1997	Lembcke et al.	
5,636,692	A	6/1997	Haugen	
5,720,349	A	2/1998	Pleasants et al.	
5,740,864	A	4/1998	de Hoedt et al.	
5,806,596	A	9/1998	Hardy et al.	
5,979,570	A *	11/1999	McLoughlin	E21B 47/18 175/24
6,050,334	A	4/2000	McGarian	
6,105,675	A	4/2000	Buytaert et al.	
6,145,593	A	11/2000	Hennig	
6,464,002	B1	10/2002	Hart et al.	
6,761,217	B1 *	7/2004	McGarian	E21B 7/061 166/117.5
6,843,314	B2 *	1/2005	Toulouse	E21B 4/02 166/117.6
7,963,341	B2	6/2011	Rios, III et al.	
2003/0034163	A1 *	2/2003	Wilson	E21B 33/127 166/387

OTHER PUBLICATIONS

Weatherford, "Whipstocks and Whipstock Mills," Brochure, Copyright 2001.

Weatherford, "QuickCut Casing Exit System RHN-Type Anchor," Brochure, Copyright 2008.

Weatherford, "QuickCut Casing Exit System PHS-Type Anchor," Brochure, Copyright 2008-2010.

Weatherford, "QuickCut Casing Exit System RHS-Type Anchor," Brochure, Copyright 2006-2012.

Weatherford, "Openhole Whipstock Anchor Rok-ANkOR System," Brochure, Copyright 2012.

Weatherford, "Re-Entry Services," Brochure, Copyright 2012.

Search Report in counterpart UK Appl. GB1509088.9, dated Aug. 25, 2015.

Second Office Action in counterpart Canadian Appl. 2,892,567, dated Apr. 24, 2017, 4-pgs.

* cited by examiner

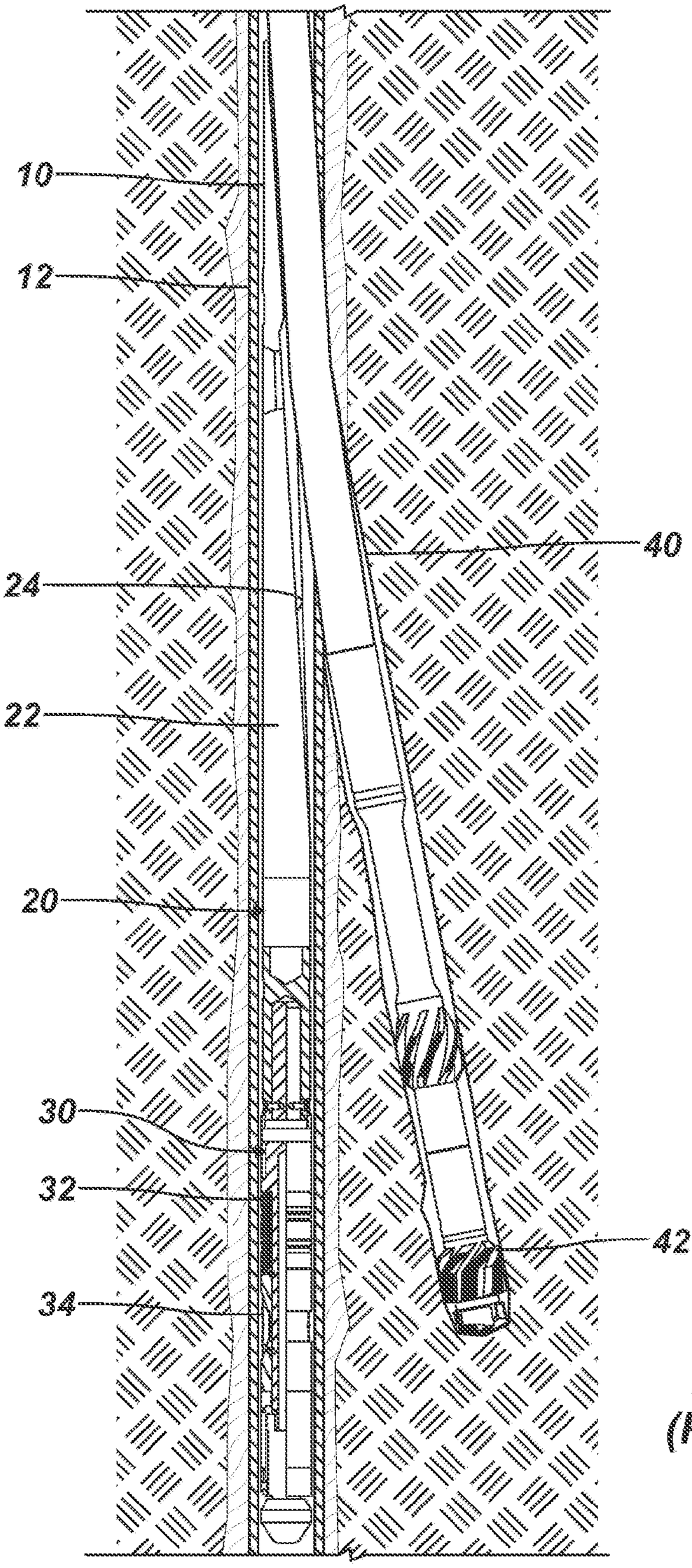


FIG. 1A
(Prior Art)

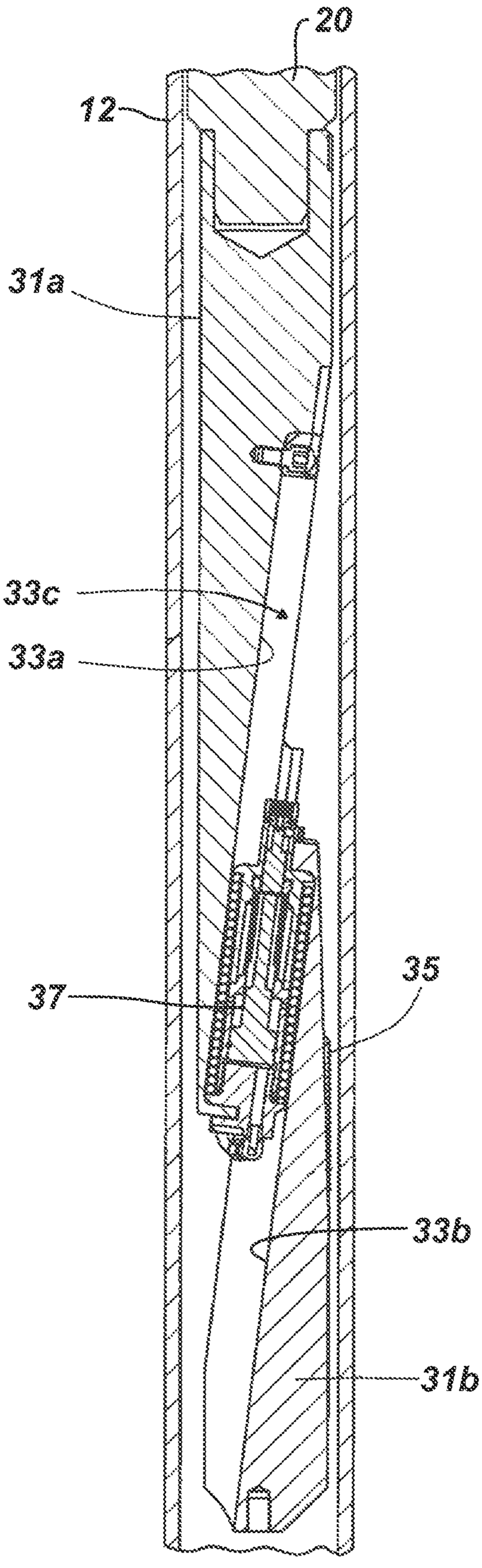
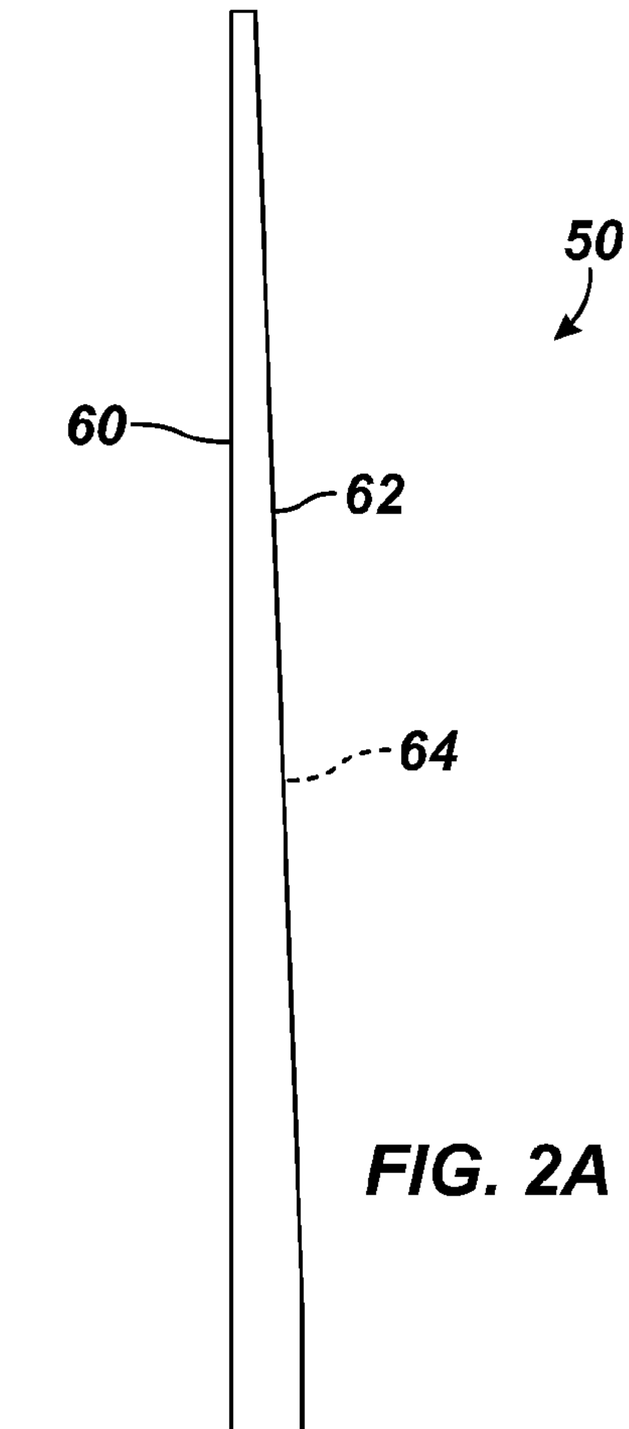


FIG. 1B
(Prior Art)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(96,98)
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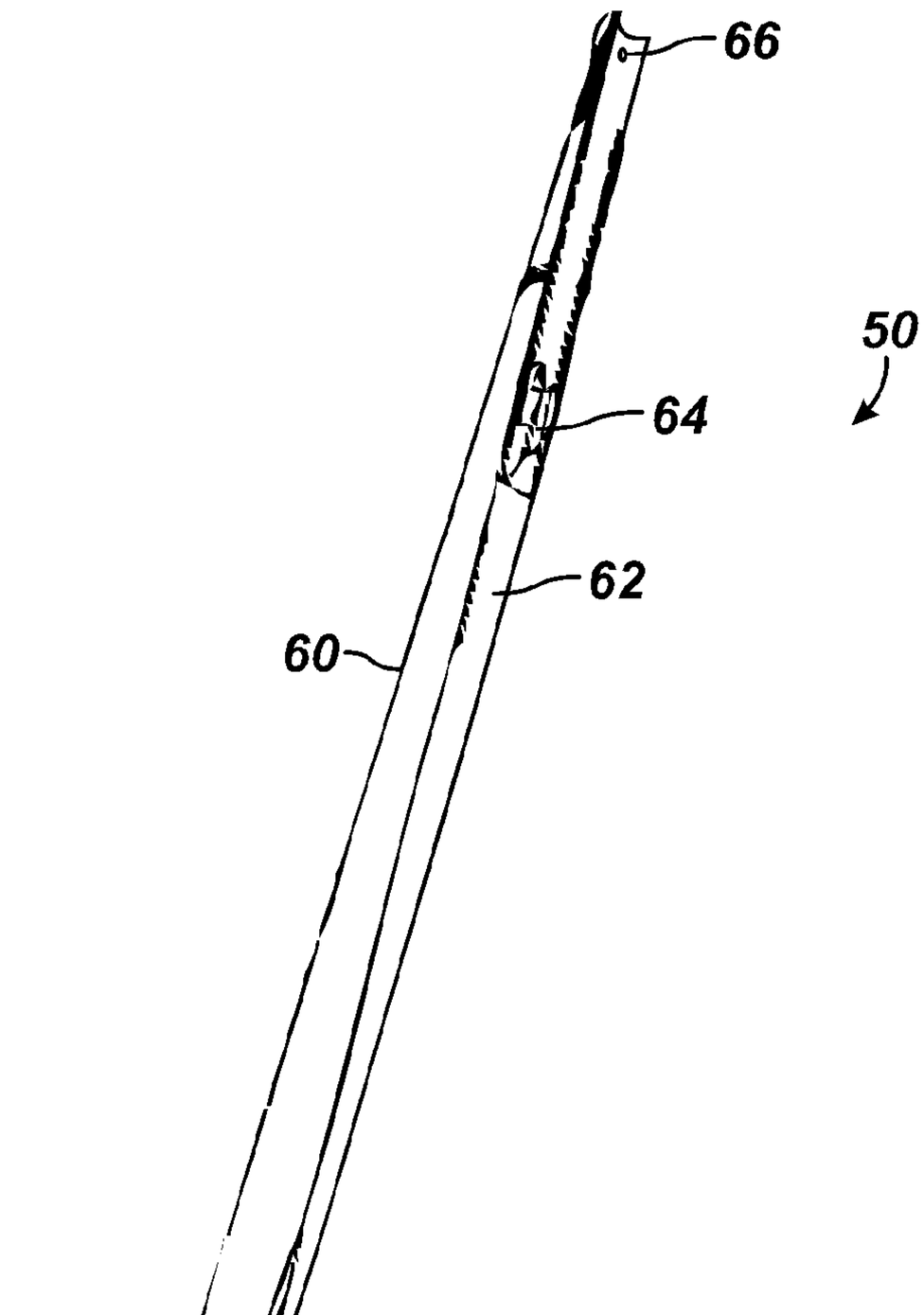
FIG. 2A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(96,98)
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FIG. 2B

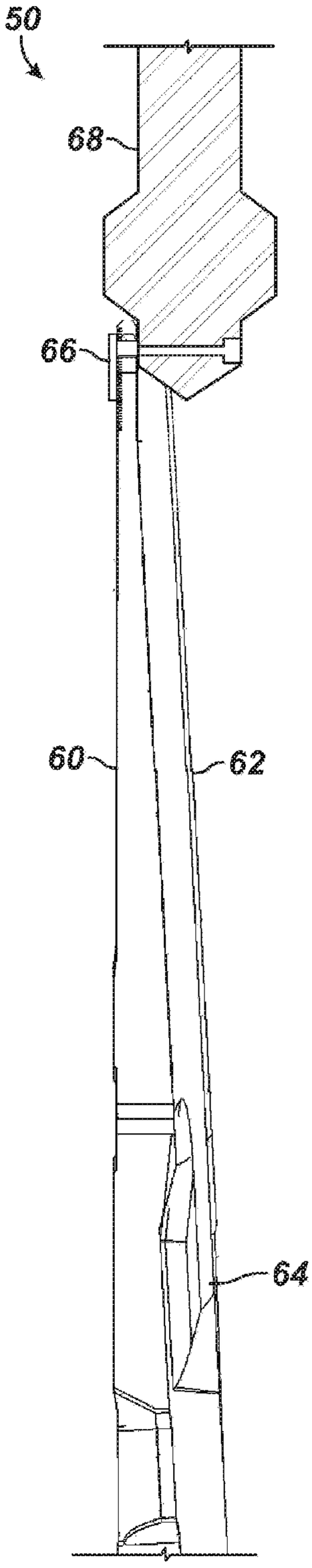

FIG. 3A

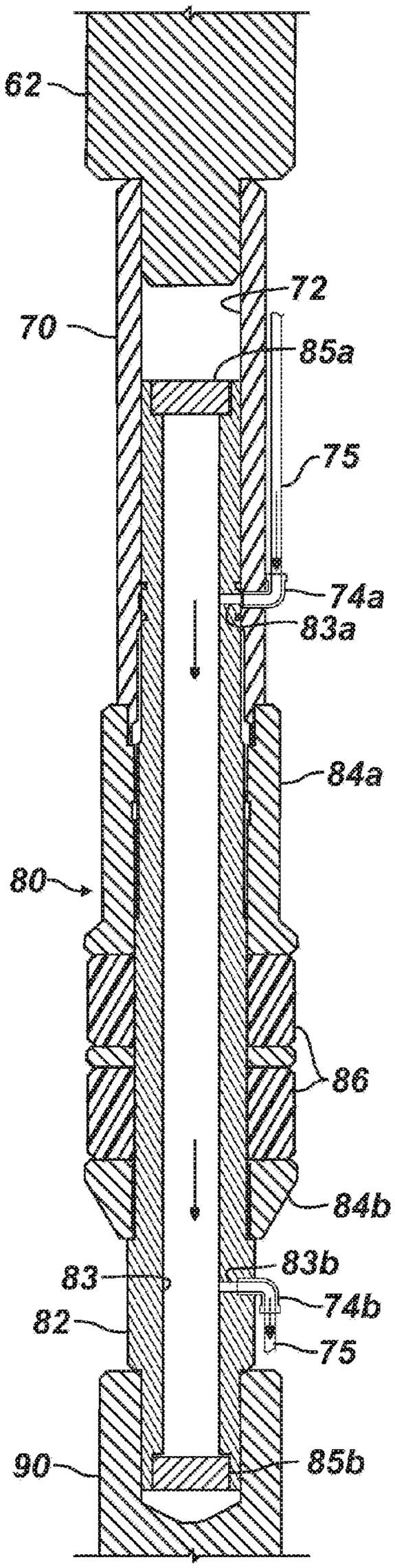

FIG. 3B

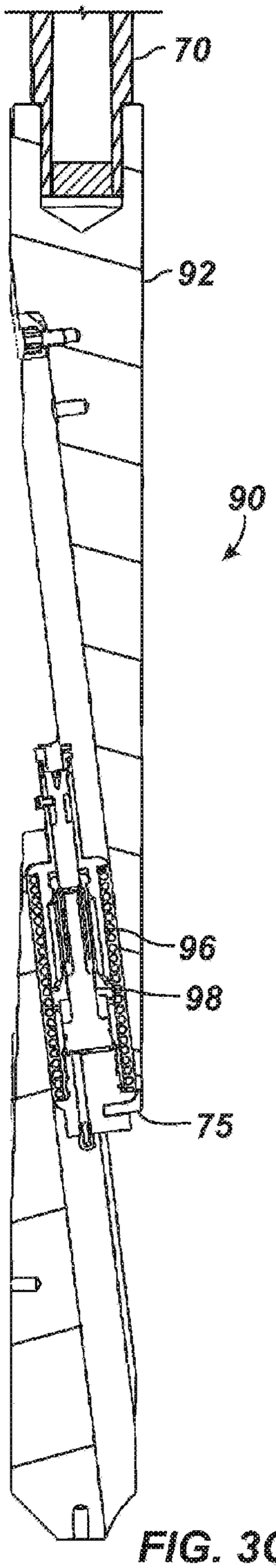

FIG. 3C

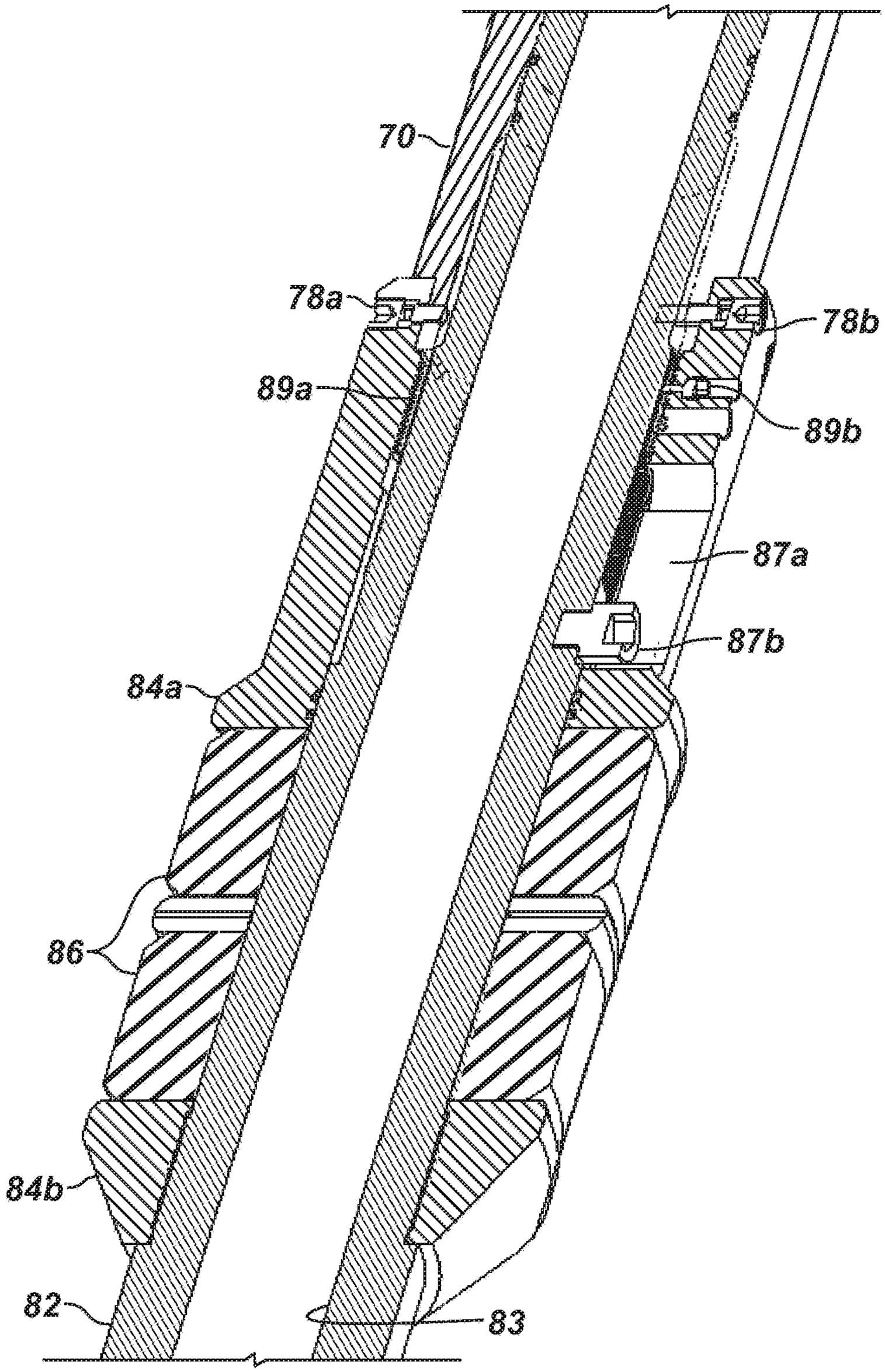

FIG. 4A

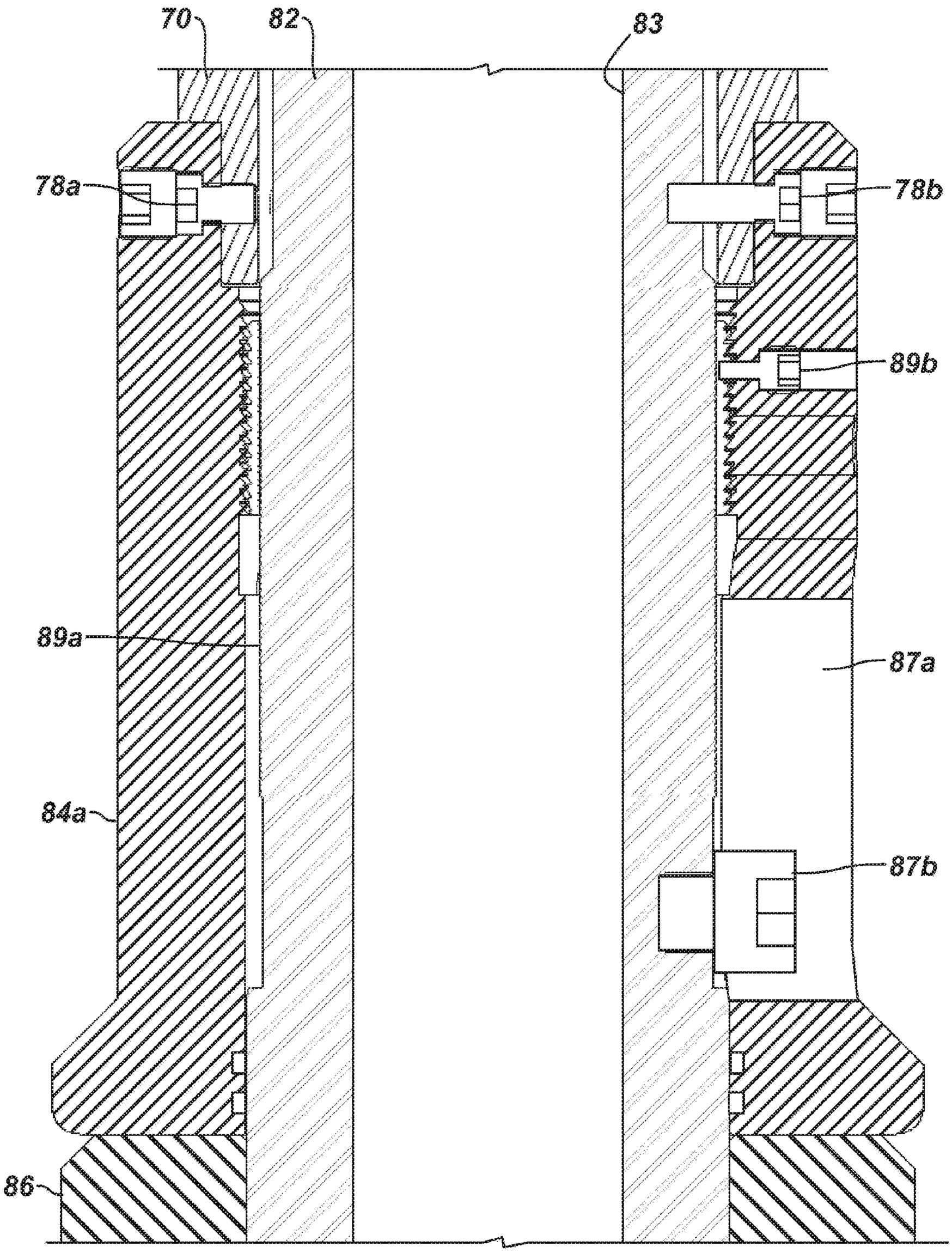

FIG. 4B

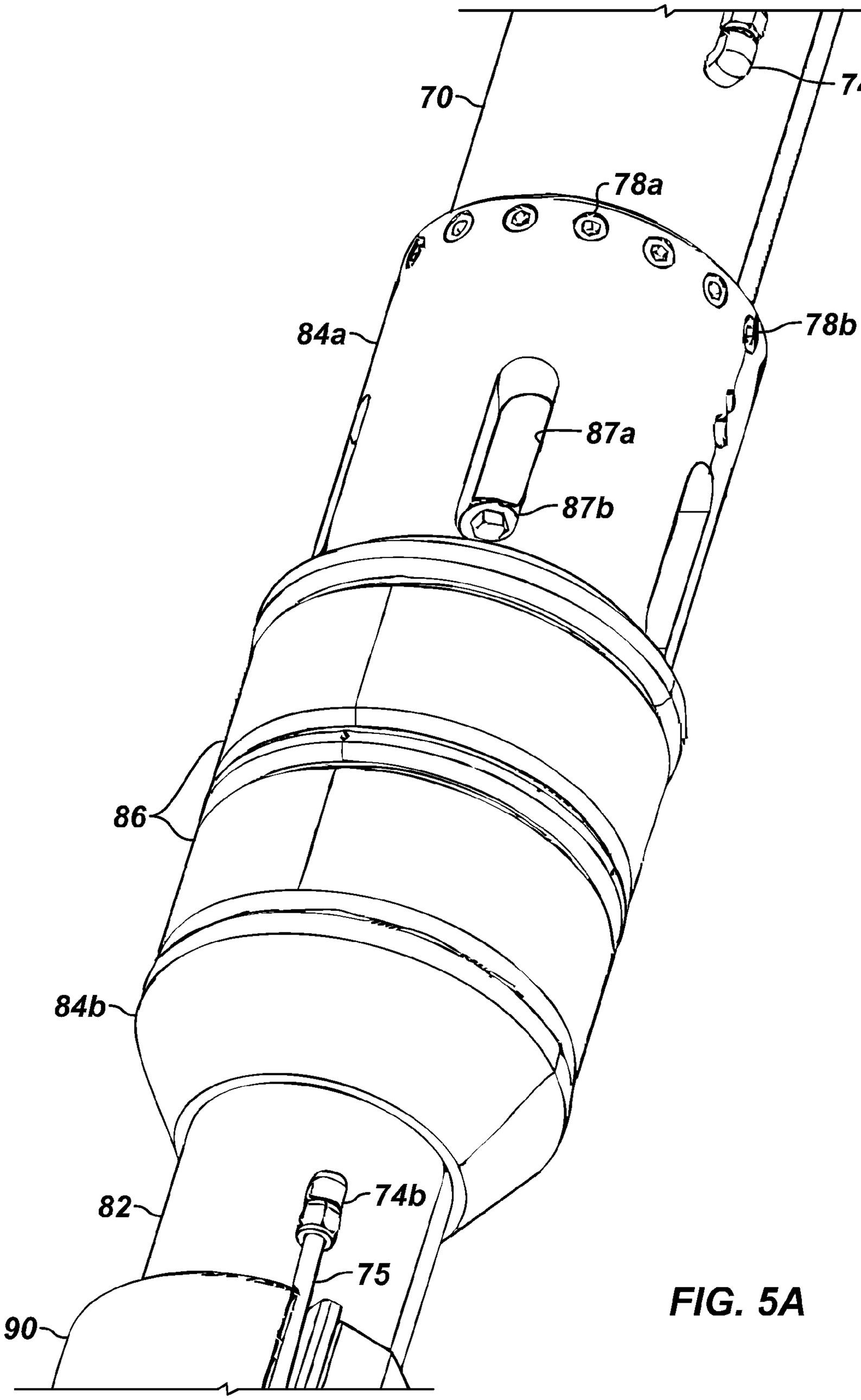

FIG. 5A

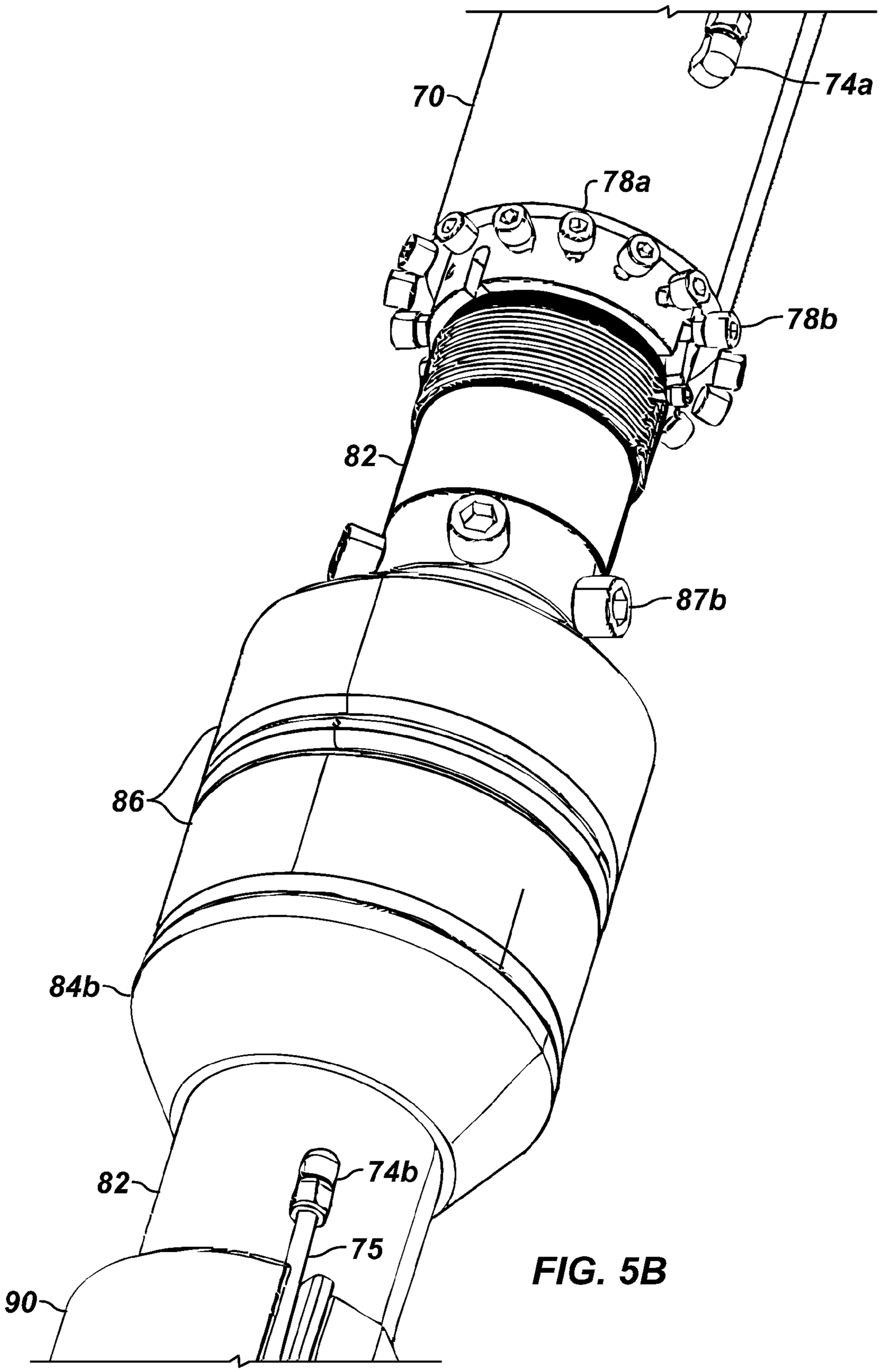

FIG. 5B

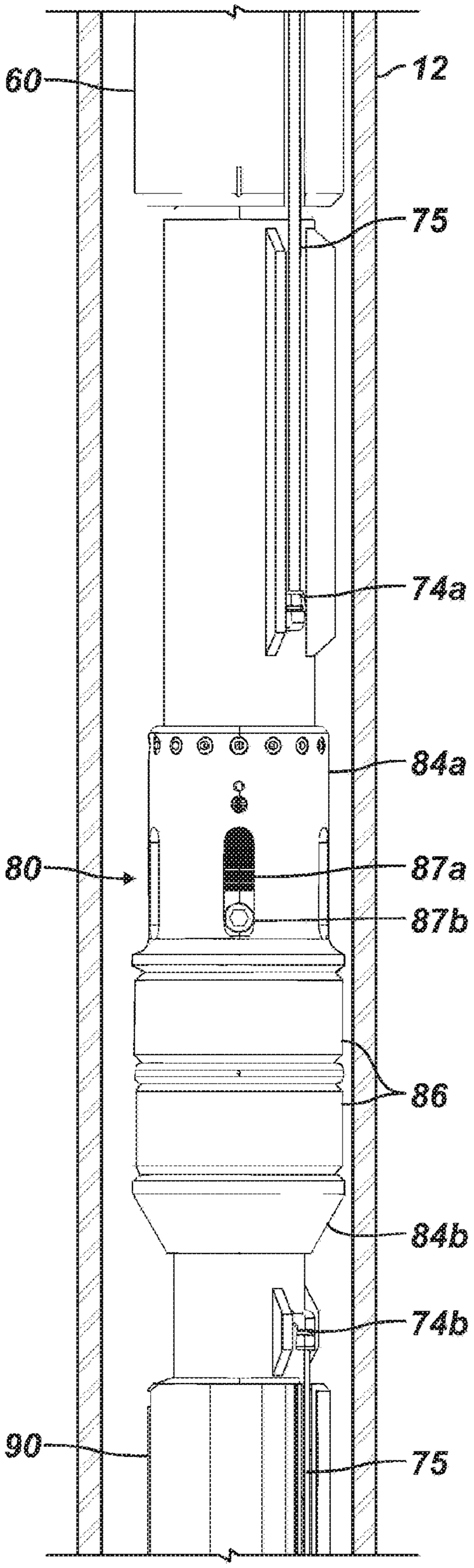
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FIG. 6A

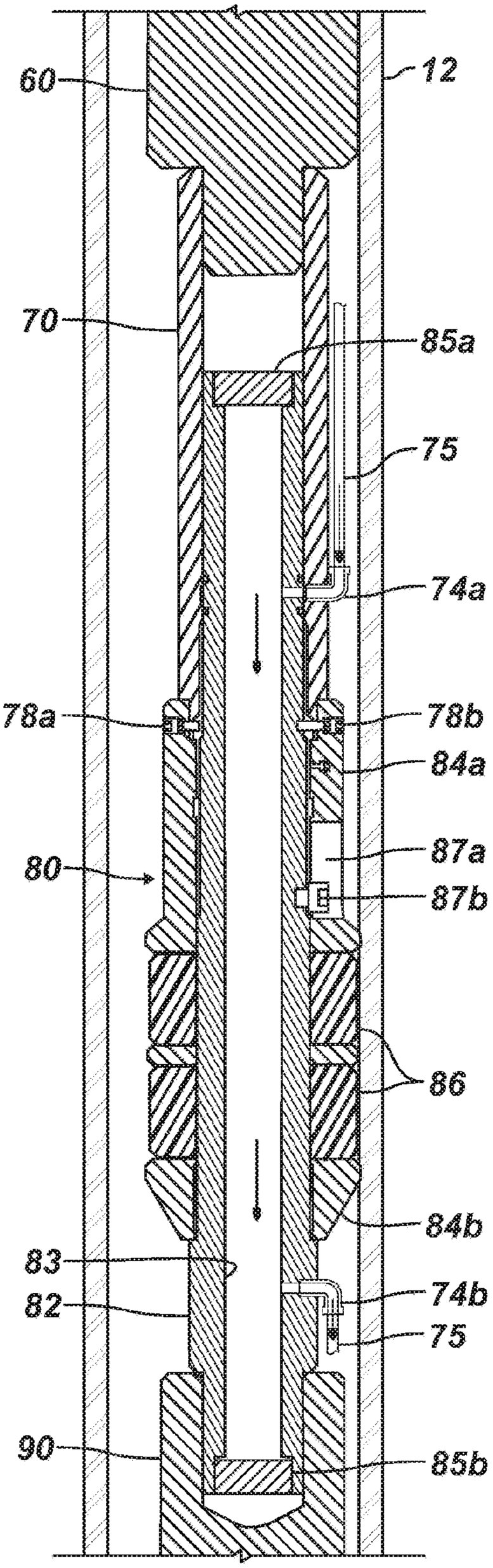
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FIG. 6B

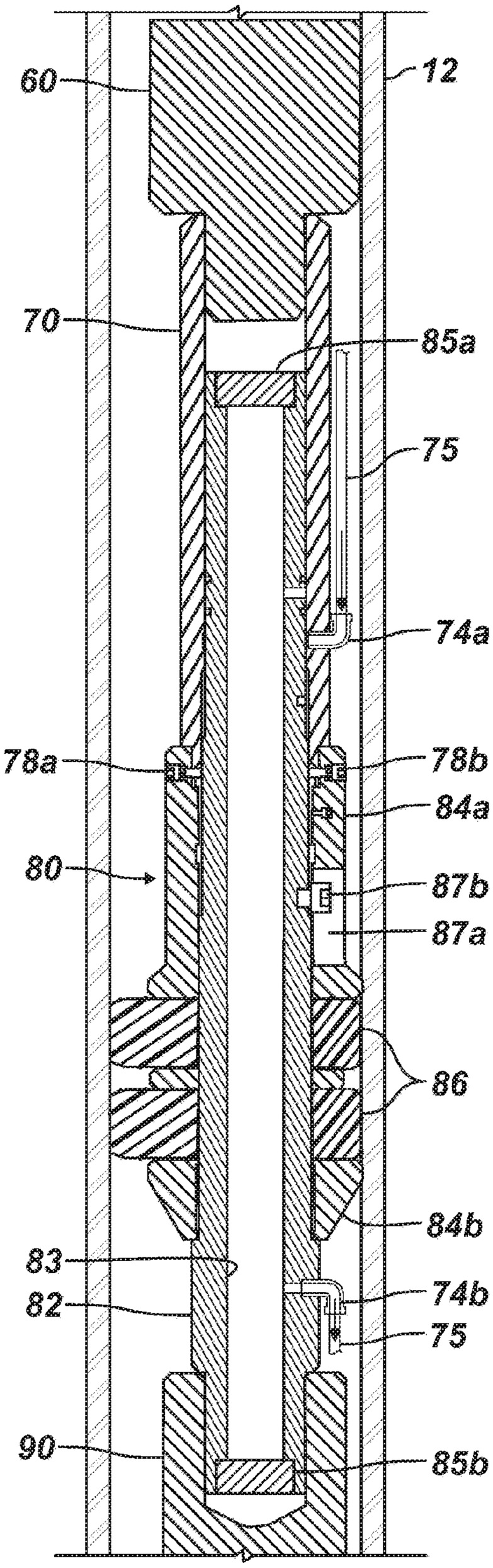
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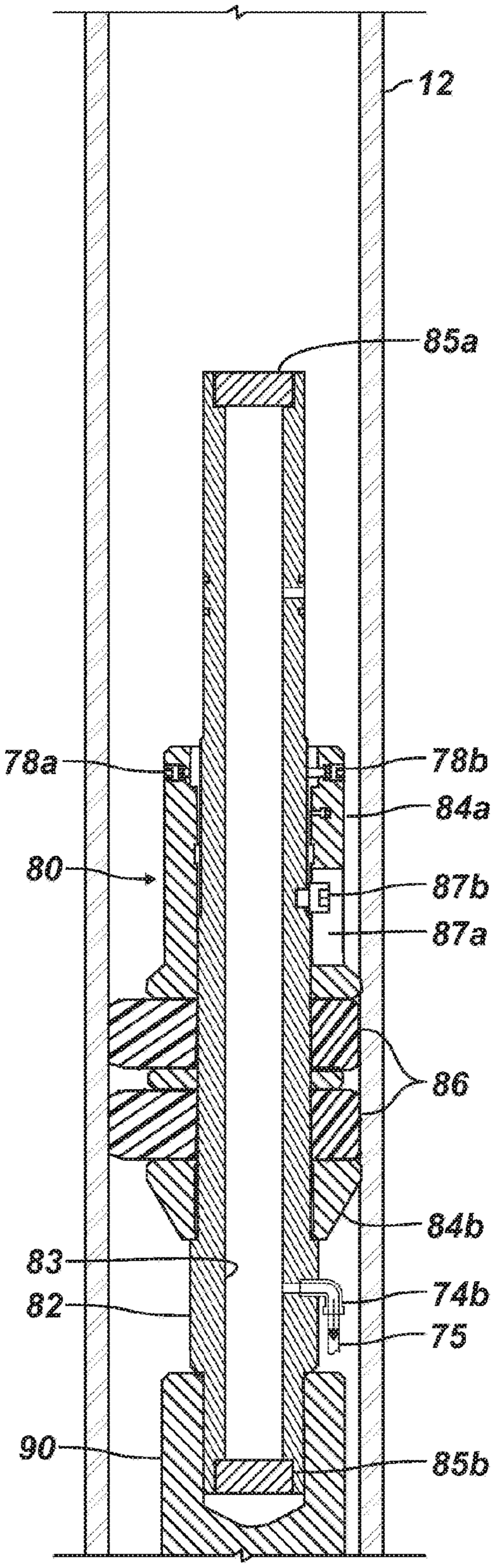
FIG. 6C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86
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85b

FIG. 6D

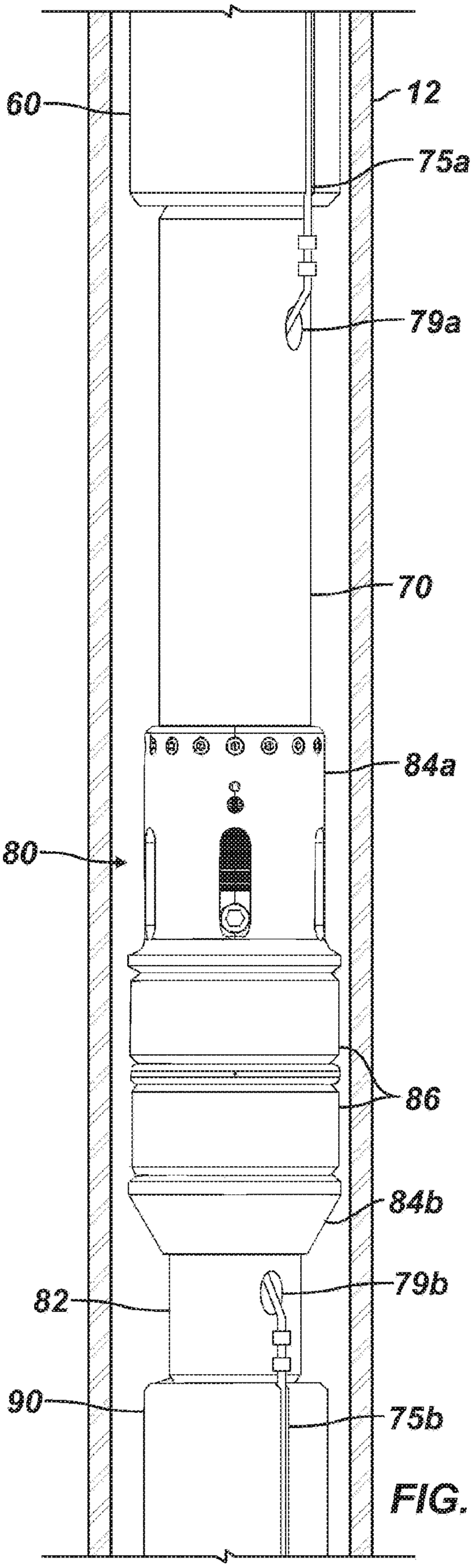
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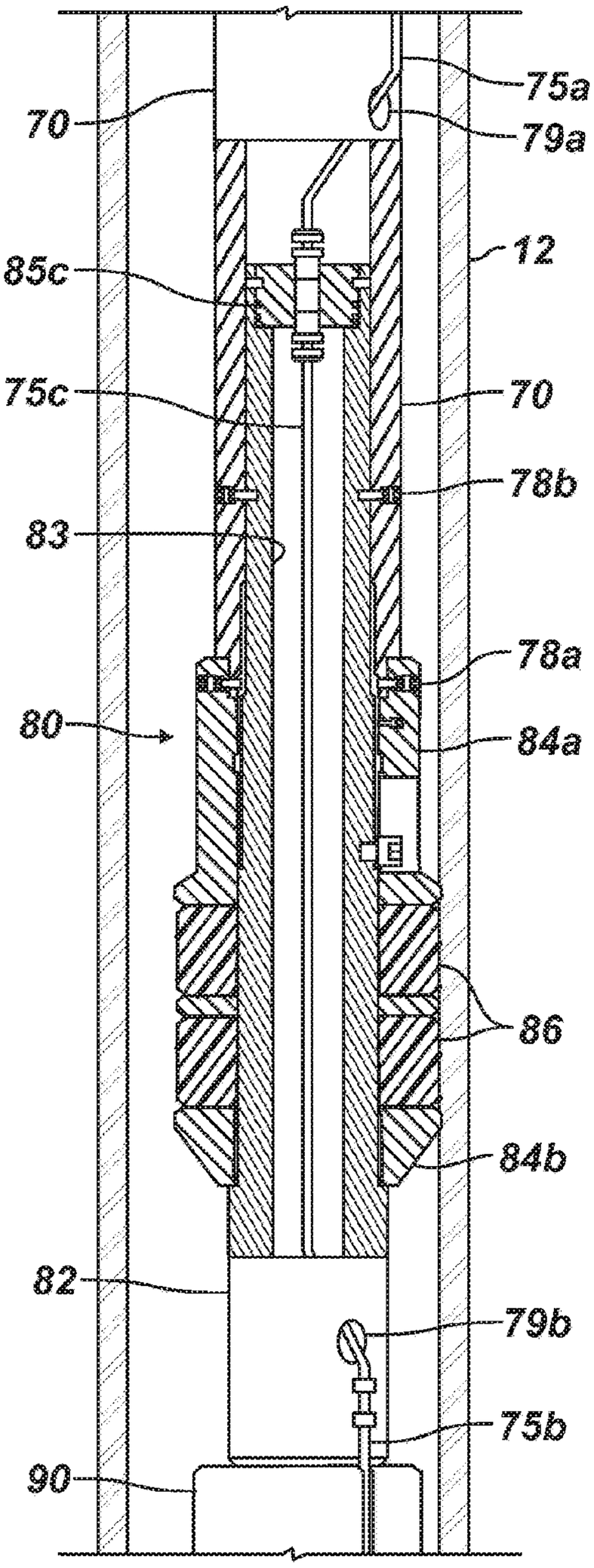
FIG. 7A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84b
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75b
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FIG. 7B

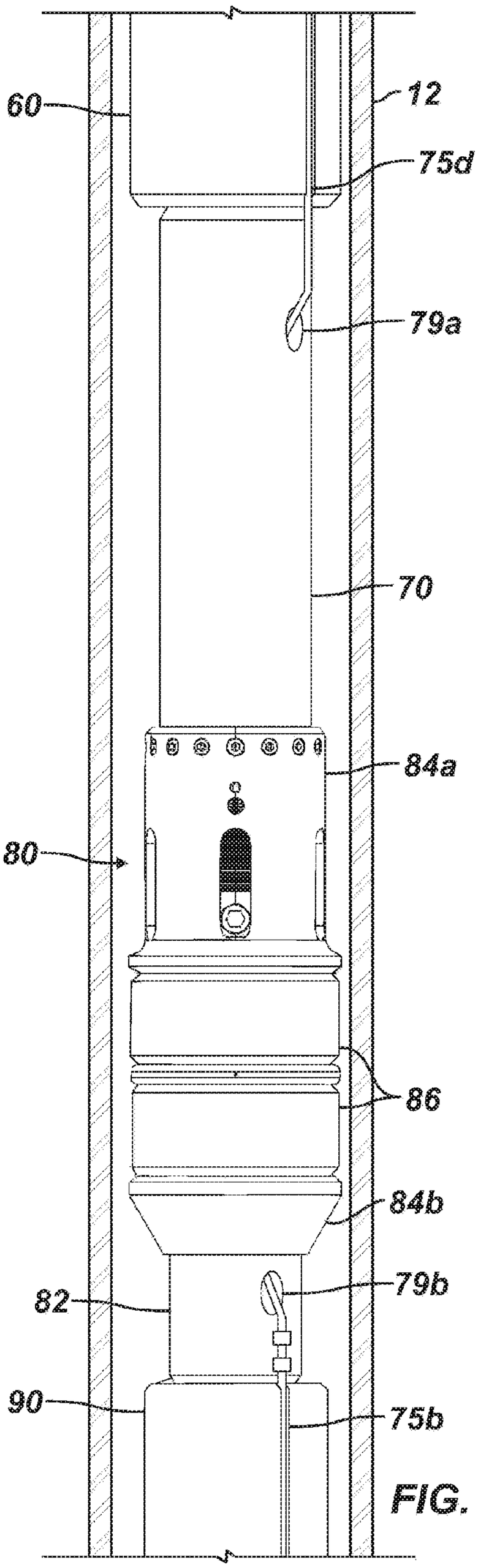
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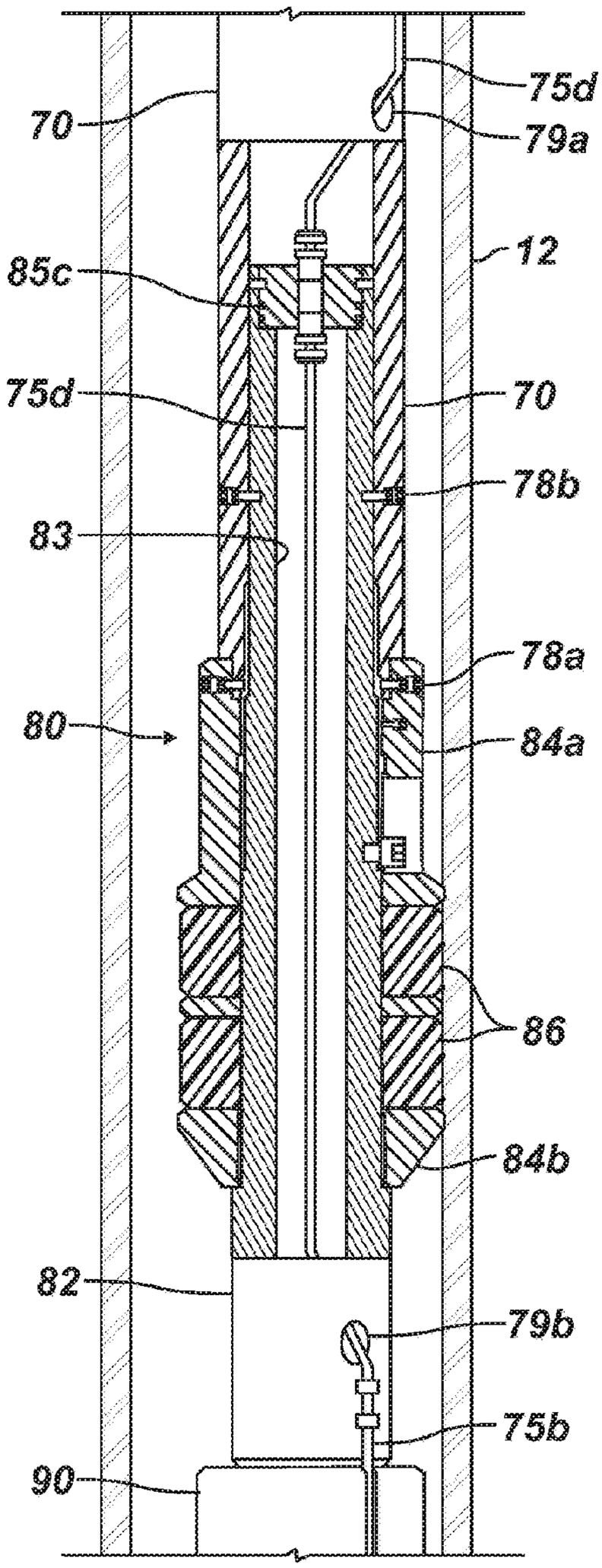
FIG. 8A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79b
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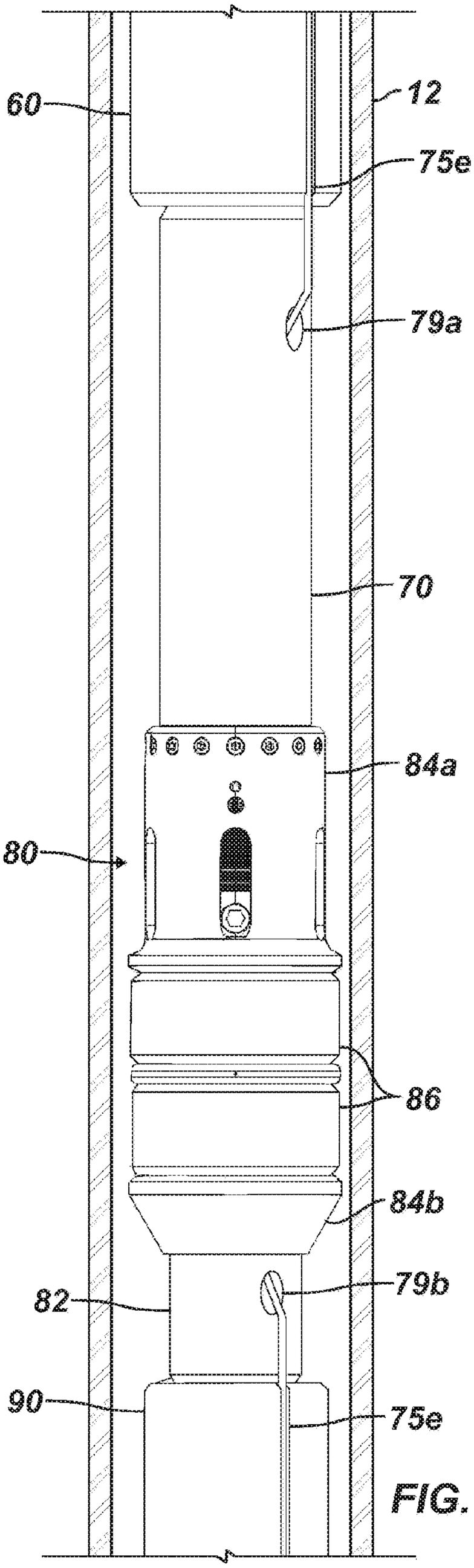
FIG. 8B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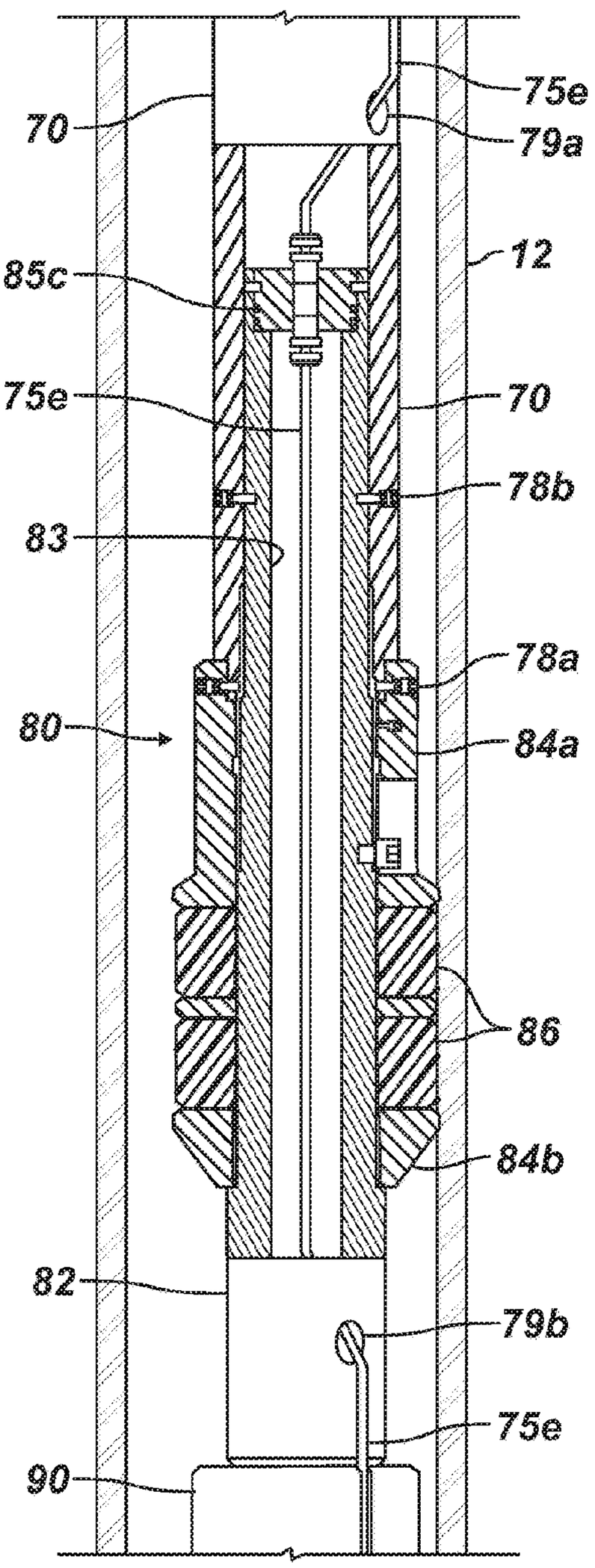
75e

FIG. 9A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79a
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FIG. 9B

WHIPSTOCK ASSEMBLY HAVING ANCHOR AND ECCENTRIC PACKER

CROSS-REFERENCE TO RELATED APPLICATIONS

This is non-provisional of U.S. patent application Ser. No. 62/004,383, filed 29, May 2014, which is incorporated herein by reference in its entirety and to which priority is claimed.

BACKGROUND OF THE DISCLOSURE

For various reasons, operators may want to cut into the side of casing in an existing wellbore so a new sidetracked or lateral wellbore can be drilled. For example, the formation adjacent the original wellbore may become depleted or damaged, or a tool or pipe may have become stuck and may have blocked further use of the original wellbore. For whatever reason, the sidetracked wellbore can be drilled and then lined with pipe for additional operational uses.

As illustrated in FIG. **1**A, a whipstock **20** according to the prior art can be used for diverting a milling tool to create a sidetracked wellbore **40**. Operators run the whipstock **20** down the original wellbore's casing **12** to the desired location. The whipstock **20** has a wedge-shaped member or whip **22** with a concave face **24** that can steer a mill or cutter **42** to the side of the casing **12** where a window will be formed. Whipstocks and their use are known, and an example is shown in U.S. Pat. No. 6,464,002, which is incorporated by reference herein in its entirety.

The whipstock **20** may be run in by itself on a setting tool, and the mill **42** can be run in after the whipstock **20** has been set. Alternatively, to save a trip, the whipstock **20** can be run in with the mill **42** temporarily attached to its upper edge. In either case, the whipstock **20** uses an anchor **30** on its end so the whipstock **20** can be anchored in the wellbore **10** at the desired location. The anchor **30** sets in the casing **12** and keeps the whipstock **20** in place to resist the downward force placed upon it as the mill **42** moves along its length through the wall of the casing **12**.

Various types of anchors can be used with the whipstock **20**, and the anchors can be set mechanically or hydraulically. Mechanically-set anchors require a compressive force to shear a pin so the anchor can be set. These mechanical anchors work well when the anchor is to be set at the bottom of a wellbore or when there is some type of restriction that has been placed in the wellbore, like a bridge plug, against which the anchor can rest. In those instances, the stationary surface available in the wellbore allows operators to generate the compressive force needed to set the mechanical anchor.

In other instances, the anchor may be positioned at some point along the wellbore where there is no surface against which to create a compressive force. In these instances, the anchor can be set with pressurized fluid and requires a hydraulic mechanism.

One particular type of hydraulically-set anchor **30** for the whipstock **20** is shown in FIG. **1**A. This anchor **30** and whipstock **20** can be similar to what is disclosed in U.S. Pat. No. 5,154,231. The hydraulically-set anchor **30** is attached to the end of the whipstock's whip **22**. A running tool (i.e., string or the mill **42**) detachably secures to the whip **22** for deployment and possible retrieval. In addition to these components, the whipstock **20** can have a locator sub with outwardly biased locator dogs (not shown) to engage in a prior milled positioning window (if formed) in the casing **12**.

With the whipstock **20** positioned in the wellbore **10**, the anchor **30** can be set to secure the whip **22** for the milling process. The running string (or mill **42** when used for run-in) can supply hydraulic fluid through a line to communicate with the anchor **30**, pressurize the anchor's mechanism, and set the anchor **30** in the casing **12**. For example, hydraulic fluid pressure is supplied to the anchor **30** and can expand slip elements **34** on the anchor **30** outwardly to engage the casing **12** and set the anchor **30**. With the anchor **30** set, the mill **42** can then mill the wellbore diversion through the wall of the casing **12**. After milling, the whipstock **20** may or may not be retrievable depending on its design.

Sometimes, the anchor **30** has a packer **32** that can isolate the lower portion of the wellbore **10** when set. Other times, isolation may not be necessary. Either way, being able to operate the packer **32** on the anchor **30** for the whipstock **20** offers some unique challenges.

One particular type of anchor **30** available in the art is shown in FIG. **1**B and is disclosed in U.S. Pat. No. 7,963,341, which is incorporated herein by reference in its entirety. This anchor **30** has first and second inclined bodies **31***a-b* with a cavity **33***c* formed between their inclined surfaces **33***a-b*. The bodies **31***a-b* can slidably move relative to each other along a portion of their inclined surfaces **33***a-b* to increase an outer diameter of the anchor **30** in a set position. A biasing member **35** disposed in the cavity **33***c* can move the anchor **30** from a run-in position to the set position with the increased outer diameter. A triggering mechanism **37** initiates movement of at least one of the bodies **31***a-b* to the set position. The triggering mechanism **37** includes a shearable connection and a releasable locking connection that releases the biasing member **35**.

Although existing whipstocks **20** and anchors **30** used in the art are effective. Operators are continually seeking new tools that can meet the new challenges experienced in the oil and gas industry around the world. For these reasons, the subject matter of the present disclosure is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

SUMMARY OF THE DISCLOSURE

A whipstock assembly positions in a wellbore having casing for forming a sidetrack. The assembly includes a whip, a packer, and an anchor. The packer extends from the whip and is mechanically activatable to seal in the casing, and the anchor extends from the packer and is activatable to anchor in the casing. The anchor sets in the casing before the packer is set. A first temporary connection between the packer and the whip releases in response to a mechanical setting force applied to the assembly, and the packer seals in the casing with the mechanical setting force. A second temporary connection between the packer and the whip releases in response to a mechanical releasing force applied to the assembly, and the whip disconnects from the packer with the mechanical releasing force.

In general, the packer has an end ring and a compressible packing element disposed thereon. The end ring is movable on the packer with the mechanical setting force and compresses the compressible packing element outward toward the casing. The packer can have at least one torque screw disposed thereon and engaged in at least one slot in the end ring, and the end ring can have a body lock connection with the packer.

In one embodiment, the anchor is a mechanically-set anchor that is mechanically activatable to anchor in the casing with a mechanical activation force. For the anchor to

be set before the packer, the mechanical activation force for the anchor is at least less than the mechanical setting force of the packer.

In another embodiment, the anchor is a hydraulically-set anchor that is hydraulically activatable to anchor in the casing. Therefore, the assembly can include a hydraulic line communicating from the whip to the anchor via the packer. In one arrangement to accommodate the hydraulics, the packer defines an internal passage, and the hydraulic line for activating the anchor passes through the internal passage from the whip to the anchor. The internal passage can have a bulkhead connector disposed therein and through which a portion of the hydraulic line passes so that the internal passage is sealed.

In an alternative arrangement, a first portion of the hydraulic line can communicate from the whip with the internal passage on one side of the packer's compressible packing element, while a second portion of the hydraulic line can communicate with the internal passage on an opposite side of the packing element to the anchor. The packer's internal passage can thereby communicate the first and second portions of the hydraulic lines with one another. In this arrangement, the packer can have seals sealing at least the first portion of the hydraulic line from the internal passage when the first temporary connection is released in response to the mechanical setting force used to set the packer.

The first temporary connection can include an intermediate member connected to the whip and movably disposed adjacent the packer's compressible packing element. One or more first shear elements temporarily affix the intermediate member to the packer. For its part, the second temporary connection can include one or more second shear elements temporarily affixing the intermediate member to the packer's end ring movable against the compressible packing element.

As noted above, the anchor is set before the packer is set in the casing. The set anchor may thereby position the unset packer eccentrically in the casing. At least a portion of the eccentrically-positioned packer acts as a fulcrum point tending to position a tip of the whip against the casing.

A method of forming a sidetrack in a wellbore having casing involves deploying in the casing a whipstock assembly having a whip, a packer extending from the whip, and an anchor extending from the packer. The whipstock assembly anchors in the casing by setting the anchor in the casing, and the packer mechanically sets in the casing with a mechanical setting force after setting the anchor. At this point, various operations can be performed, namely forming the sidetrack in the wellbore with the assembly set in the casing.

Setting the anchor in the casing before setting the packer can involve positioning the unset packer eccentrically in the casing. In this way, at least a portion of the eccentrically-positioned packer can be used as a fulcrum point to urge a tip of the whip against the casing, which can have advantages disclosed herein.

Setting the anchor can involve mechanically setting the anchor with a mechanical activation force at least less than the mechanical setting force used for the packer. Alternatively, setting the anchor can involve communicating hydraulics from the whip to the anchor through the packer. To do this, a hydraulic line can communicate from the whip to the anchor through an internal passage of the packer.

In another arrangement, a first portion of a hydraulic line from the whip communicates to an internal passage of the packer on one side of a compressible packing element, while a second portion of the hydraulic line communicates from internal passage of the packer on an opposite side of the compressible packing element to the anchor. When the first temporary connection is released in response to the mechanical setting force, at least the first portion of the hydraulic line can seal from the internal passage.

Mechanically setting the packer in the casing involves moving an end ring on the packer with the mechanical setting force against a compressible packing element on the packer and compressing the compressible packing element outward toward the casing. This is done by freeing a first temporary connection of the assembly with the mechanical setting force applied to the assembly.

For the first temporary connection, an intermediate member connected to the whip is provided that is movably disposed adjacent the packer's compressible packing element. A temporarily affixing of this intermediate member to the packer can then be sheared so that the mechanical setting force can be applied to the packer's compressible packing element.

Eventually, the whip of the assembly can mechanically disconnect from the packer by freeing a second temporary connection between the packer and the whip with a mechanical releasing force applied to the assembly. Disconnecting the whip by freeing the second temporary connection between the packer and the whip with the mechanical releasing force can then involve shearing another temporarily affixing of the intermediate member to the packer's end ring, which is movable against the compressible packing element.

The foregoing summary is not intended to summarize each potential embodiment or every aspect of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A illustrates a whipstock assembly according to the prior art for diverting a milling tool to create a sidetrack wellbore.

FIG. **1**B illustrates an anchor according to the prior art for a whipstock assembly.

FIG. **2**A illustrates an elevational view of a whipstock assembly according to the present disclosure.

FIG. **2**B illustrates a perspective view of the disclosed whipstock assembly.

FIGS. **3**A-**3**C illustrate detailed cross-sectional views of the disclosed whipstock assembly.

FIGS. **4**A-**4**B illustrate cross-sectional views of the packer on the disclosed whipstock assembly.

FIG. **5**A-**5**B illustrate details of the upper end ring of the packer and surrounding components on the disclosed whipstock assembly.

FIGS. **6**A-**6**D illustrate the disclosed whipstock assembly during operation downhole.

FIGS. **7**A-**7**B illustrate another whipstock assembly according to the present disclosure in elevational and cross-sectional views.

FIGS. **8**A-**8**B illustrate the whipstock assembly in elevational and cross-sectional views with another hydraulic line arrangement.

FIGS. **9**A-**9**B illustrate the whipstock assembly in elevational and cross-sectional views with yet another hydraulic line arrangement.

DETAILED DESCRIPTION OF THE DISCLOSURE

FIGS. **2**A-**2**B illustrate an elevational view and a perspective view of a whipstock assembly **50** according to the

present disclosure. The whipstock assembly **50** includes a whip **60**, an intermediate member **70**, a packer **80**, and an anchor **90**.

The whip **60** is a wedge-shaped member with a concave face **62** that can steer a mill or a cutter (not shown) to the side of casing where a window can be formed. The intermediate member **70** connects the packer **80** to the lower end of the whip **60**. The packer **80** is a permanent, compression-set packer that is run below the whip **60** and above the anchor **90** on the assembly **50**. As will be discussed later, the packer **80** is set after the anchor **90** has been set.

The anchor **90** can be set with hydraulic pressure using a hydraulic line **75**, or the anchor **90** can be activated with set-down weight so no hydraulic line is required. For the hydraulically-set anchor **90**, the hydraulic line **75** extends from a coupling (**66**: FIG. **2**B) on the tip of the whip **60** where the setting tool or mill (e.g., **68**: FIG. **3**A) connects to the whip **60** for deploying the assembly **50**. From there, the control line **75** passes along the intermediate member **70** to the packer **80** and then to the anchor **90**.

In one arrangement, the packer **80** has an internal bypass for the transmission of hydraulic pressure to set the anchor **90**. Alternatively, the hydraulic line **75** is run inside the packer **80** so the hydraulic line **75** can pass to the anchor **90**. Further details of these features are discussed later.

For a mechanically-set anchor **90**, use of the control line **75** is not necessary. In this case, the packer's internal dimension can be plugged with a small fitting to seal a fluid passage that would be present in the packer **80** for communicating with the hydraulically-set anchor **90**. For example, the packer **80** can be filled with fluid and can have a mechanism that seals off the inside of the packer **80** as the packer **80** is set.

As noted above, the anchor **90** can be mechanically-set or hydraulically-set. Shown here, the anchor **90** is actuated hydraulically so the hydraulic line **75** runs from the whip **60**, through the packer **80**, and to the mechanisms of the anchor **90** so hydraulic fluid from a running tool or the like affixed at the whip **60** can communicate to the anchor **90** and set it in the casing **12**.

As shown, the anchor **90** is similar to that shown in FIG. **1**B and disclosed in U.S. Pat. No. 7,963,341, which is incorporated herein by reference in its entirety. The anchor **90** has first and second inclined bodies **92** and **94** with a cavity formed between their inclined surfaces. The bodies **92** and **94** can slidably move relative to each other along a portion of their inclined surfaces to increase an outer diameter of the anchor **90** to a set position. A biasing member (**96**) disposed in the cavity can move the anchor's bodies **92**, **94** from a run-in position to the set position with the increased outer diameter. A triggering mechanism (**98**) initiates movement of at least one of the bodies **92** or **94** to the set position. The triggering mechanism (**98**) includes a shearable connection and a releasable locking connection that releases the biasing member (**96**).

Discussion now turns to FIGS. **3**A-**3**B, looking at the packer **80** and adjacent components of the assembly **50** in more detail. As shown in FIG. **3**A, a detailed view of the whipstock assembly **50** illustrates a tip of the whip **60** with the mill **68** placed to attach at the coupling **66** on its distal end. FIG. **3**B shows the proximal end of the whip **60** affixed to the packer **80** by the intermediate member **70**. The packer **80** is also shown affixed to the upper end of the anchor **90**. Finally, FIG. **3**C shows details of the hydraulically-set anchor **90**.

As best shown in FIG. **3**B, the packer **80** includes a mandrel **82** having an upper (movable) end ring **84***a* and a lower (fixed) end ring **84***b* disposed thereon. One or more compressible packing elements **86** are disposed on the mandrel **82** between the end rings **84***a-b* and can be compressed between them during activation (discussed below). The mandrel **82** defines an internal bore **83** communicating along its length.

To communicate hydraulics from the whip **60** to the anchor **90**, the hydraulic line **75** as shown in FIG. **3**B extends from the whip **60** along the outside of the intermediate member **70**. Terminating at a fitting **74***a*, hydraulic fluid from the line **75** can communicate through the intermediate member **70** and a mandrel port **83***a* into the bore **83** of the mandrel **82**, which is disposed at least partially in a bore **72** of the intermediate member **70**.

Communicated inside the mandrel's bore **83**, the hydraulic fluid is held therein by end caps or seals **85***a-b* disposed at each end of the bore **83**. The end caps **85***a-b* can be welded or otherwise affixed in place. This creates a fluid-filled chamber through packer **80**. The hydraulic fluid from the bore **83** can pass through another mandrel port **83***b* to a fitting **74***b* on the lower end of the mandrel **82**. From this fitting **74***b*, the hydraulic line **75** can run along the anchor **90** to then communicate with the anchor's trigger components **98**.

Although the anchor **90** is operated hydraulically, the packer **80** is operated mechanically by the interaction of the whip **60**, intermediate member **70**, and upper end ring **84***a*. Turning to the operation of the packer **80**, discussion turns to FIGS. **4**A-**4**B and **5**A-**5**B, which show various views of the packer **80**. In particular, FIGS. **4**A-**4**B illustrate perspective and elevational views of the packer **80** in cross-section. FIG. **5**A-**5**B illustrate the outside of the packer **80** in a perspective view and a partially exposed view with components missing.

The upper (movable) end ring **84***a* is disposed on the packer mandrel **82** and is affixed with shear screws **78***a-b*, pins, elements, or other temporary fixture. A first set of shear screws **78***a* affixes the end ring **84***a* to the intermediate member **70**. A second set of the shear screws **78***b* affixes the end ring **84***a* to the mandrel **82**.

To set the packer **80** by moving the upper end ring **84***a* against the packing elements **86** and against the lower (fixed) end ring **84***b*, the intermediate member **70** as discussed below pushes the upper end ring **84***a*. The first shear screws **78***a* do not shear free when the intermediate member **70** is forced downward along the mandrel **82** during setting procedures discussed below. The second shear screws **78***b*, however, do shear free when the intermediate member **70** is forced downward along the mandrel **82** at a mechanical setting force. The first shear screws **78***a* can be sheared free when the intermediate member **70** is forced upward during release procedures discussed below.

The shear values for set down with the second set of shear screws **78***b* may be lower than the shear valves for release with the first set of shear screws **78***a*. Moreover, if the anchor **90** is mechanically set, then any shear value associated with the anchor's setting would be lower than setting shear values for the packer **80**.

Torque screws **87***b* on the mandrel **82** can ride in guide slots **87***a* on the end ring **84***a*. The torque screws **87***b* transmit torque from the whip **60** to the anchor **90**, and the torque screws **87***b* can slide in the slots **87***a* during packer setting. To hold the upper end ring **84***a* in a set state compressed against the packing elements **86**, a body lock ring **89***b* on the end ring **84***a* can lockably engage teeth **89***a* disposed on the mandrel **82**, allowing movement toward the packing elements **86***a-b* and preventing reverse movement.

Overall, the assembly **50** mechanically sets the packer **80** after the anchor **90** has been set either mechanically or hydraulically. Operation of the packer **80** on the assembly **50** is shown in FIGS. **6**A-**6**D.

As shown more specifically in FIG. **6**A, the packer **80** is unset while the assembly **50** is run in the casing **12**. Fins or ribs can protect the hydraulic line **75** along the outside of the intermediate member **70** and portion of the anchor **90**. Likewise, the whip **60** and the anchor **90** may define channels for the hydraulic line **75**.

During run in, the upper end ring **84***a* is held affixed to the intermediate member **70**, and the intermediate member **70** is held affixed to the packer mandrel **82** by the shear screws **78***a-b*. In this position, the torque screws **87***b* are disposed in the lower end of the guide slots **87***a* on the end ring **84***a*. Of course, during run in, the anchor **90** is not set, and hydraulic pressure is not yet communicated through the line **75** and mandrel bore **83** to activate the anchor **90**.

As shown in FIG. **6**B, the assembly **50** reaches the desired depth on the casing **12** where the sidetrack wellbore is to be made. Hydraulic pressure is then communicated through the control line **75** and the mandrel bore **83** to activate the anchor **90** and hold the assembly **50** in the casing **12**. The hydraulic line fittings **74***a-b* redirect the high pressure setting fluid through the internal bore **83** of the packer **82**. The integrity of the hydraulic control line **75** between the packer **80** and the anchor **90** remains intact after the anchor **90** is set, and the piston chamber inside the anchor **90** continues to hold pressure.

Once the anchor **90** is set as shown in FIG. **6**C, the packer **80** sets against the casing **12** on one side and has a large extrusion gap on the opposite side into which the packing element **86** seals when compressed. In this position, the assembly **50** uses a portion of the packer **80** (e.g., the lower gage ring **84***b*) as a fulcrum point to force the tip (not shown) of the whip **60** against the casing **12**. Then, the packer **80** once set is arranged not to move the tip of the whip **60** away from the casing **12**.

To actually set the packer **80** after the anchor **90** is set, operators put weight on the assembly **50** using the running tool (not shown), which is affixed to the whip **60**. Weight is applied by the whip **60** and the intermediate member **70** to shear the screws **78***b*. Freed from the mandrel **82**, the end ring **84***a* moves along the mandrel **82** and compresses against the packing elements **86**. For example, the weight required to initiate setting may be about 20-25K lb. Then, the minimum weight required to set the packer **80** in the casing **12** can be about 40K lb, and the maximum weight to sustain without losing seal can be about 65K lb. These values are merely exemplary.

As shown in FIG. **6**C, the weight from the whip **60** moves the intermediate member **70** against the shear screws **78***b* connecting the end ring **84***a* to the mandrel **82**, and the setting shear screws **78***b* shear while stroking down and holding torque. Shearing free, the end ring **84***a* is pressed against the packer elements **86**, which in turn are compressed by the lower end ring **84***b*.

When shifted to set the packer **80**, the intermediate member **70** eventually seals off the hydraulics. In particular, O-ring seals are disposed on the packer mandrel **82** adjacent the port **83***a* for the hydraulic fitting **74***a*. As the intermediate member **70** slides along the mandrel **82** during setting of the packer **80**, the fitting **74***a* slides past the hydraulic port **83***a*. This seals off the fluid path and can be useful if the hydraulic line **75** below the packer **80** leaks.

Under the compression, the packer element **86** extends outward to engage inside the casing **12** to create a fluid seal. As noted above, the set anchor **90** causes the packer **80** to be forced against one side of the casing **12** as a portion of the packer **80** is used as a fulcrum point for pushing the tip of the whip **60** against the casing **12**. Because the packer **80** is forced against the casing **12**, a very large extrusion gap is formed on one side. The other side of the packer **80** has a very small or no extrusion gap. Therefore, the packing elements' material is preferably capable of moving both circumferentially and radially to pack off in the casing **12**. The packing element **86** may also be preconfigured with more material on one side to accommodate the expected extrusion gap relative to the casing **12** when the anchor **90** is set.

With the anchor **90** and packer set **80**, operations can continue. For instance, the setting tool (not shown) is disengaged from the whip **60**, and milling of a sidetrack wellbore is performed according to standard procedures. The packer **80** transmits torque generated by the milling operation through it to the anchor **90** below.

Once the sidetrack wellbore is completed (i.e., drilled, lined with pipe, perforated, etc.), the whip **60** can be removed from the assembly **50**, leaving the packer **80** and the anchor **90** in place. To do this, operators engage the whip **60** with a pulling tool (not shown) at a profile (e.g., **64**) and pull up on the whip **60** against the packer **80** and anchor **90** set in the casing **12**. As shown in FIG. **6**D, the intermediate member **70** eventually shears free of the packer mandrel **82** by shearing the first set of shear screws **78***a* used to connect the intermediate member **70** to the upper end ring **84***a*.

The packer **80** and anchor **90** can then be removed according to conventional practices. For example, a milling operation can free the packer **80** from engagement with the surrounding casing **12** so the packer **80** can be washed out. Also, the exposed end of the packer mandrel **82** acts a fishing neck for retrieval.

In addition to shearing of the whip **60** followed by the milling/washover of the packer **80**, there are other contingency retrieval operations that can be implemented. For example, retrieval may need to be performed while the assembly **50** is being run in the well to depth and being oriented. If the assembly **50** sets prematurely, the operators will want to remove the entire assembly **50** and bring it to surface. Should the assembly **50** pre-set, the operators can shear the whip **60** from the assembly **50** and can also retrieve the packer **80** and anchor **90** as a unit. This presupposes that the friction of the anchor **90** in the casing is less than the shear value. This retrieval operation can also be used if the operators want to retrieve the assembly **50** even if set properly to depth and after the desired window has been milled.

In the previous version of the packer **80**, the inner bore **83** of the packer **80** is used for communicating high-pressure hydraulic fluid to the anchor **90**. The bore **83** is filled with fluid and has a mechanism that seals off the inside of the packer **80** as the packer **80** is set. In another version, the hydraulic line **75** can be run through a bulkhead type connector inside the packer **80** to communicate fluid to the anchor **90**.

In particular, FIGS. **7**A-**7**B illustrate an elevational view and a partial cross-sectional view of another whipstock assembly **50** according to the present disclosure. This assembly **50** is similar to that discussed previously so that like reference numerals are used for similar components. Rather than communicating the hydraulic pressure for the anchor **90** through the bore **83** of the packer mandrel **82**, the current arrangement uses one or more intermediate control lines **75***c*

and an end cap **85***c* to communicate the hydraulics from the whip **60**, through the packer **80**, and to the anchor **90**.

As shown, the line **75***a* from the whip **60** terminates and connects to an intermediate line **75***c* with tubing union fittings. The intermediate line **75***c* then passes through an opening **79***a* and into the intermediate member **70**. The intermediate line **75***c* affixes with fittings (e.g., two Swagelok straight connectors) to the end cap **85***c* in the mandrel **82**, and the intermediate line **75***c* continues and passes through the mandrel's bore **83** to an opening **79***b* downhole on the packer **80**. Here, the intermediate line **75***c* connects with tubing union fittings to the lower line **75***b*, which extends to the anchor **90**.

The end cap **85***c* is a bulkhead connector sealed and affixed in the mandrel's bore **83**. The hydraulic line **75***c* is sealed with fittings to the bulkhead connector **85***c* so the line **75***c* can pass through the connector **85***c*. In this way, the bulkhead connector **85***c* prevents fluid from bypassing the packer **80** through the mandrel's bore **83**.

Setting of the anchor **90** and packer **80** can be performed as before. The setting shear screws **78***b* affixing the intermediate member **70** to the mandrel **82** can be disposed as before or can be positioned as shown in FIG. **7**B. The release shear screws **78***a* can be disposed as before. When the whip **60** is removed along with the intermediate member **70**, the various fittings of the hydraulic line **75***a* may be severed so that the exposed end of the packer mandrel **82** can form a fishing neck as before.

In FIGS. **7**A-**7**B, the assembly **50** uses three hydraulic lines **75***a*, **75***b*, and **75***c*. As an alternative shown in FIGS. **8**A-**8**B, one hydraulic line **75***d* can be used that runs from the intermediate member **70**, through the opening **79***a*, through the bulkhead connector **85***c*, along the inner bore **83** of the packer mandrel **82**, and out the lower opening **79***b*. A bore-through fitting can be used at the bulkhead connector **85***c*. At this point, the line **75***d* can attach to the anchor's line **75***b* with tubing union fittings. This arrangement eliminates a leakage path between the lines **75***a* and **75***c* of FIG. **7**B.

In another alternative shown in FIGS. **9**A-**9**B, another leakage path can be eliminated by using a single hydraulic line **75***e*. The assembly **50** is the same as in FIGS. **8**A-**8**B except that the one hydraulic line **75***e* runs from the intermediate member **70**, through the packer **80**, and to the mandrel **90**. Use of hydraulic fittings at the lower end towards the anchor **90** is eliminated. As expected, the hydraulic line **75***e* is longer to cover the entire length of the anchor **90** where it is to be connected.

The foregoing description of preferred and other embodiments is not intended to limit or restrict the scope or applicability of the inventive concepts conceived of by the Applicants. It will be appreciated with the benefit of the present disclosure that features described above in accordance with any embodiment or aspect of the disclosed subject matter can be utilized, either alone or in combination, with any other described feature, in any other embodiment or aspect of the disclosed subject matter.

In exchange for disclosing the inventive concepts contained herein, the Applicants desire all patent rights afforded by the appended claims. Therefore, it is intended that the appended claims include all modifications and alterations to the full extent that they come within the scope of the following claims or the equivalents thereof.

What is claimed is:

1. A whipstock assembly positioning with a setting tool in a wellbore having casing for forming a sidetrack, the assembly comprising:

a whip removably coupled to the setting tool;

a packer extending from the whip and being settable to seal in the casing; and

an anchor extending from the packer and being settable separate from the packer to anchor in the casing,

the anchor setting first in the casing in a first setting stage with the packer unset,

the packer setting in the casing with a mechanical setting force initiated by a downhole motion of the setting tool against the set anchor in a second setting stage once the anchor has set in the first setting stage.

2. The assembly of claim **1**, wherein the anchor comprises a hydraulically-set anchor being hydraulically activatable to anchor in the casing, the assembly further comprising a hydraulic line communicating from the whip to the anchor via the packer.

3. The assembly of claim **1**, wherein the anchor comprises a mechanically-set anchor being mechanically activatable to anchor in the casing with a mechanical activation force at least less than the mechanical setting force of the packer.

4. The assembly of claim **1**, wherein the packer comprises an end ring and a compressible packing element disposed thereon, the end ring being movable on the packer with the mechanical setting force and compressing the compressible packing element outward toward the casing.

5. The assembly of claim **4**, wherein the packer comprises at least one torque screw disposed thereon and engaged in at least one slot in the end ring.

6. The assembly of claim **4**, wherein the end ring comprises a body lock connection with the packer allowing movement with the mechanical setting force against the compressible packing element and preventing reverse movement.

7. The assembly of claim **1**, wherein the set anchor positions the unset packer eccentrically in the casing, at least a portion of the eccentrically-positioned packer acting as a fulcrum point tending to position a tip of the whip against the casing.

8. The assembly of claim **1**, wherein the packer defines an internal passage, a hydraulic line for setting the anchor passing through the internal passage from the whip to the anchor.

9. The assembly of claim **8**, wherein the internal passage comprises a bulkhead connector disposed therein and through which a portion of the hydraulic line passes from the whip to the anchor.

10. The assembly of claim **1**, wherein the packer defines an internal passage, a first portion of a hydraulic line for setting the anchor communicating from the whip with the internal passage on one side of a compressible packing element on the packer, a second portion of the hydraulic line communicating with the internal passage on an opposite side of the packing element to the anchor, the internal passage communicating the first and second portions of the hydraulic lines with one another.

11. The assembly of claim **10**, wherein the packer seals at least the first portion of the hydraulic line from the internal passage when set with the mechanical setting force.

12. The assembly of claim **1**, comprising a first temporary connection between the packer and the whip releasing in response to the mechanical setting force applied to the assembly.

13. The assembly of claim **12**, wherein the first temporary connection comprises:

an intermediate member connected to the whip and movably disposed adjacent a compressible packing element of the packer; and

one or more first shear elements temporarily affixing the intermediate member to the packer.

14. The assembly of claim **13**, further comprising a second temporary connection between the packer and the whip releasing in response to a mechanical releasing force applied to the assembly, the whip disconnecting from the packer with the mechanical releasing force.

15. The assembly of claim **14**, wherein the second temporary connection comprises one or more second shear elements temporarily affixing the intermediate member to an end ring of the packer adjacent the compressible packing element.

16. A whipstock assembly positioning with a setting tool in a wellbore having casing for forming a sidetrack, the assembly comprising:

a whip removably coupled to the setting tool;

a packer extending from the whip and being mechanically activatable in a second setting stage to seal in the casing with a mechanical setting force;

an anchor extending from the packer and being activatable in a first setting stage separate from the packer with a downhole motion of the setting tool to anchor in the casing with the packer unactivated; and

a first temporary connection between the packer and the whip releasing in response to the mechanical setting force applied to the assembly and initiating the setting of the packer with the downhole motion of the setting tool against the activated anchor in the second setting stage once the anchor has set in the first setting stage in the casing.

17. The assembly of claim **16**, further comprising a second temporary connection between the packer and the whip releasing in response to a mechanical releasing force applied to the assembly, the whip disconnecting from the packer with the mechanical releasing force.

18. A method of forming a sidetrack in a wellbore having casing, the method comprising:

deploying, in the casing with a setting tool, a whipstock assembly having a whip, a packer extending from the whip, and an anchor extending from the packer;

anchoring the whipstock assembly in the casing by setting the anchor separate from the packer in a first setting stage in the casing with the packer unset;

mechanically setting the packer in the casing with a mechanical setting force initiated by a downhole motion of the setting tool against the set anchor in a second setting stage once the anchor has set in the first setting stage; and

forming the sidetrack in the wellbore using the whip of the whipstock assembly.

19. The method of claim **18**, wherein setting the anchor in the casing comprises mechanically setting the anchor with a mechanical activation force at least less than the mechanical setting force of the packer.

20. The method of claim **18**, wherein setting the anchor in the casing comprises setting the anchor with hydraulics communicated from the whip to the anchor through the packer.

21. The method of claim **20**, wherein setting the anchor with the hydraulics communicated from the whip to the anchor through the packer comprises communicating a hydraulic line from the whip to the anchor through an internal passage of the packer.

22. The method of claim **20**, wherein setting the anchor with the hydraulics communicated from the whip to the anchor through the packer comprises communicating a first portion of a hydraulic line from the whip to an internal passage of the packer on one side of a compressible packing element, and communicating a second portion of the hydraulic line from internal passage of the packer on an opposite side of the compressible packing element to the anchor.

23. The method of claim **22**, further comprising sealing, with the packer, at least the first portion of the hydraulic line from the internal passage when setting the packer with the mechanical setting force.

24. The method of claim **18**, wherein mechanically setting the packer in the casing with the mechanical setting force after setting the anchor comprises moving an end ring on the packer with the mechanical setting force against a compressible packing element on the packer and compressing the compressible packing element outward toward the casing.

25. The method of claim **18**, wherein mechanically setting the packer in the casing with the mechanical setting force after setting the anchor comprises freeing a first temporary connection of the assembly with the mechanical setting force applied to the assembly.

26. The method of claim **25**, wherein freeing the first temporary connection of the assembly with the mechanical setting force applied to the assembly comprises:

providing an intermediate member connected to the whip and movably disposed adjacent a compressible packing element of the packer; and

shearing a temporarily affixing of the intermediate member to the packer.

27. The method of claim **26**, further comprising mechanically disconnecting the whip of the assembly from the packer by freeing a second temporary connection between the packer and the whip with a mechanical releasing force applied to the assembly.

28. The method of claim **27**, wherein freeing the second temporary connection between the packer and the whip with the mechanical releasing force applied to the assembly comprises shearing another temporarily affixing of the intermediate member to an end ring of the packer adjacent the compressible packing element.

29. The method of claim **18**, wherein setting the anchor in the casing before setting the packer comprises positioning the unset packer eccentrically in the casing, and using at least a portion of the eccentrically-positioned packer as a fulcrum point to urge a tip of the whip against the casing.

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